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Canadian Science Advisory Secretariat
Newfoundland and Labrador Region | Science Response 2017/034

NORTHERN (NAFO DIVS. 2J3KL) COD STOCK UPDATE

Context

A conservation limit reference point (LRP) was established for Northern cod in 2010 (DFO 2011) and is defined as the average spawning stock biomass (SSB) during the 1980s. This reference point defines the boundary between the critical and cautious zones within the Precautionary Approach (PA) framework (DFO 2009) and defines the stock level below which serious harm is occurring and the ability to produce good recruitment is seriously impaired. The most recent assessment (March 2016) used an integrated catch-at-age Northern Cod Assessment Model (NCAM, Cadigan 2016b, DFO 2016) to determine population size of the Northern cod stock. Conclusions based on this model were that the stock size (SSB) has increased considerably over the past decade to 34% of the LRP but remains in the critical zone of the DFO PA framework. In addition, projections indicate a low probability (5-8%) that the SSB would reach the LRP by 2018 and a low risk (< 4%) of SSB declining below the 2015 value. The scientific advice from the most recent full assessment (DFO 2016) stated that removals should be kept to the lowest possible level to promote stock growth. There are no explicit timelines for stock rebuilding upon which to base advice, but a rebuilding plan for this stock is currently under development.

The Northern cod stock has been subjected to ongoing stewardship and recreational fisheries in the inshore since 2006. The previous multi-year management plan (2013-15) for the stewardship fishery was an individual quota (IQ) based plan, whereby each harvester was permitted an annual allowance of 2.3 t (= 5,000 lb). The management approach changed in 2016 from an IQ for the stewardship fishery to weekly landing limits per fisher (2,000 lbs from August 15-September 4 then 3,000 lbs from September 4-December 16), and the requirement that fish could be caught only within the fisher's home bay was removed.

The recreational fishing season was extended in 2016, with recreational fishers being allowed to fish on weekends, including both Canada Day and Labour Day, in addition to the two week season in summer and fall. This was an increase of 14 days from 2015 to 2016. Recreational fishers were permitted a maximum catch of five fish per day or person, or 15 fish per boat per trip when three of more people were fishing together.

The full assessment in March 2016 provided three-year science advice from the period March 2016 to March 2019.The purpose of this Science Response Report is to update stock status and compare resource status based on data obtained in 2016 with projections from last year's NCAM results.

This Science Response Report results from the Science Response Process of March 22, 2017 on the Northern Cod (Divs. 2J3KL) Stock Update. The meeting reviewed information from:

1. the DFO autumn research vessel (RV) survey (specifically: indices of abundance and biomass);
2. the inshore sentinel catch rate index; and
3. fishery exploitation rates based on tagging.

Analysis and Response

Reported landings

A stewardship fishery for cod and a recreational fishery for groundfish were permitted in the inshore during 2016. Reported landings in 2016 were 10,164 t compared with 4,435 t in 2015. Reported landings comprised 9,875 t in the stewardship fishery, 205 t in the sentinel surveys, and 19 t taken as by-catch. Catches outside the Canadian EEZ (200 mile limit, Fig. 1) during 2016 are not yet available, but have generally been < 300 t during the past five years. Recent history of reported landings is summarized in Appendix Table 1.

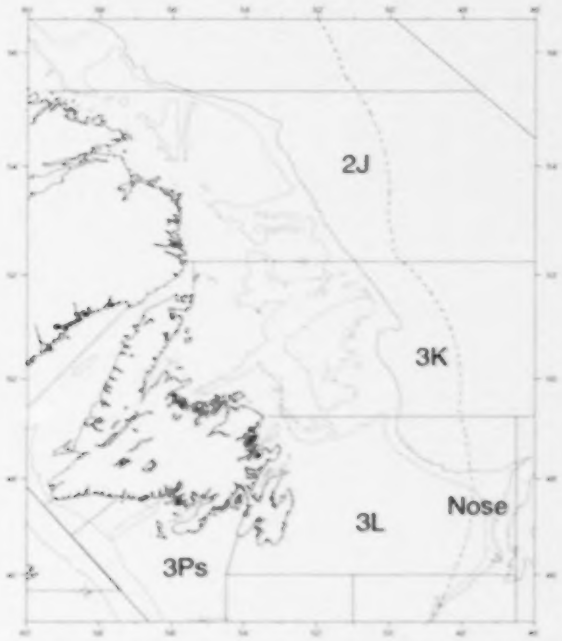

Figure 1: Stock area of Northern (Divs. 2J3KL) cod. The dashed line indicates Canada's 200 nautical mile Exclusive Economic Zone (EEZ).

There are no requirements to report recreational landings. However, information from tagging indicates that in some years, recreational landings are substantial and that total removals are much higher than reported landings (see below in Tagging section).

Stock Trends

Bottom-trawl surveys

Typically, only abundance and biomass indices from the DFO RV survey are presented during an update. Therefore, SSB was not calculated. The abundance and biomass indices from the autumn DFO RV surveys have been low since the start of the moratorium in 1992 (Figs. 2 and 3). The abundance index increased during 2005-09 and the biomass index increased during 2005-08; these increasing trends did not persist during 2009-11, but resumed in 2012 and have continued to 2016. Most of the increase in biomass in 2016 was in Div. 3K (Fig. 3). In 2016, most of the abundance (86%) and biomass (87%) indices are located in the northern portion of the stock area (Divs. 2J and 3K). In the mid-1980s, approximately 60% of the

abundance and 66% of the biomass index was located in Divs. 2J3K, indicating that more of the stock was located in Div. 3L in the past.

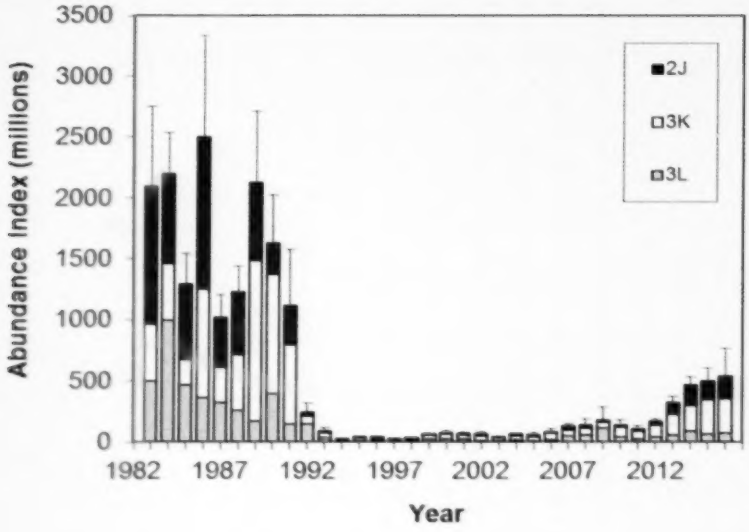

Figure 2: Offshore abundance index (+2 SE's) from autumn RV surveys in Divs. 2J3KL.

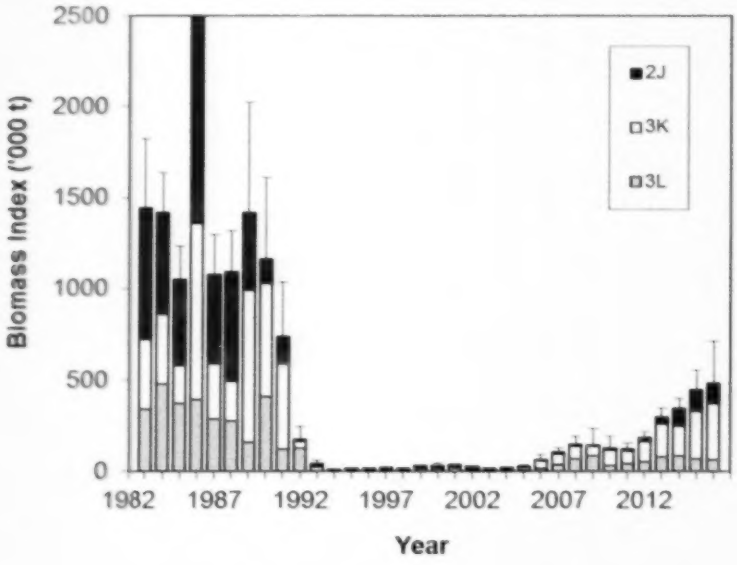

Figure 3: Offshore biomass index (+2 SE's) from autumn RV surveys in Divs. 2J3KL.

The three-year averages (2014-16) for the total abundance and biomass indices are 28% and 29%, respectively, of the average during the 1980s. Annual values for these indices are summarized (by NAFO Division) in Appendix Table 2.

Northern Cod Assessment Model (NCAM)

The 2016 assessment was based on an integrated state-space population dynamics model developed specifically for Northern cod (NCAM). This new model integrates much of the existing information about the productivity of the stock (Cadigan 2016a and b).

Indicators and procedure to trigger full assessment during interim years

This stock is currently on a three-year management/assessment cycle and stock status indicators will be provided from interim updates conducted during periods when there is no full assessment scheduled. Total biomass from the autumn DFO RV survey is used as an interim year indicator of stock status (DFO 2016). This index covers most of the stock area. A full assessment would be triggered before the three year cycle, if the autumn DFO RV survey total biomass is outside the 75% CI of the NCAM model projected RV biomass value for 2016 or 2017.

The 2016 DFO-RV survey biomass index (481,298 t) is 7% higher than the 2015 index (447,581 t). The total survey biomass index in 2016 is used for the comparison (rather than age 2+ biomass), because ages are not yet available and the contribution of cod < age 2 to the total biomass is negligible. Observed change in survey total biomass from the fall of 2015 to the fall of 2016 is compared with the corresponding projected change in age 2 + survey biomass, from the NCAM model, within the appropriate catch projection. Given a total estimated catch in 2016 that is double (2X) the NCAM estimate of the 2015 catch, the percentage change in the observed RV survey between 2015 and 2016 (Fig. 4) falls within the 75% confidence intervals projected by NCAM (-0.3% to 45%). A full assessment is therefore not triggered. For future stock updates, projected values from the 2016 assessment can only be used to evaluate the trigger if the harvest level does not change during the interim years as each projection scenario assumes a constant catch.

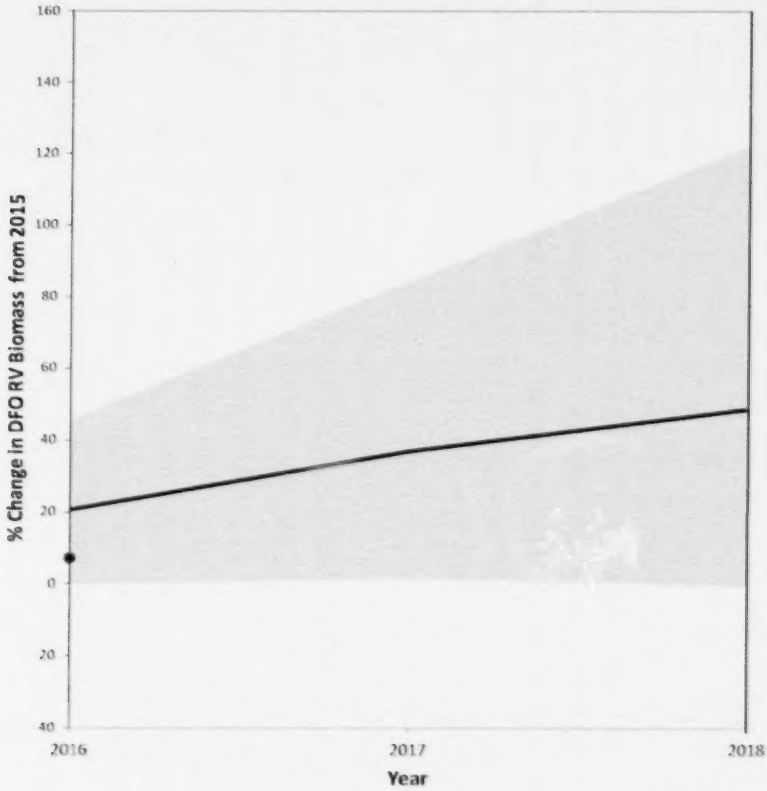

Figure 4: Projected percent change in the DFO RV total biomass index from 2015 (solid line) assuming that catch is double the 2015 estimate, with 75% CIs (grey envelope) projected from 2017-18 by the NCAM assessment model. Solid symbol is observed increase in the biomass index (7%) from the 2015 to 2016 autumn DFO RV survey.

Sentinel Catch Rates – Inshore

Age-aggregated analysis of sentinel catch rate data was carried out and combined into a total for Divs. 2J3KL. Previous details of the sentinel survey can be found in Maddock Parsons (2014).

Sentinel survey mean catch rates are preliminary as ageing of samples from the 2016 sentinel fishery was not complete (and samples from 2015 were used). Catch rates for 5½ inch mesh gillnet (GN) declined in 2016 but remained above the long term mean (Fig. 5).

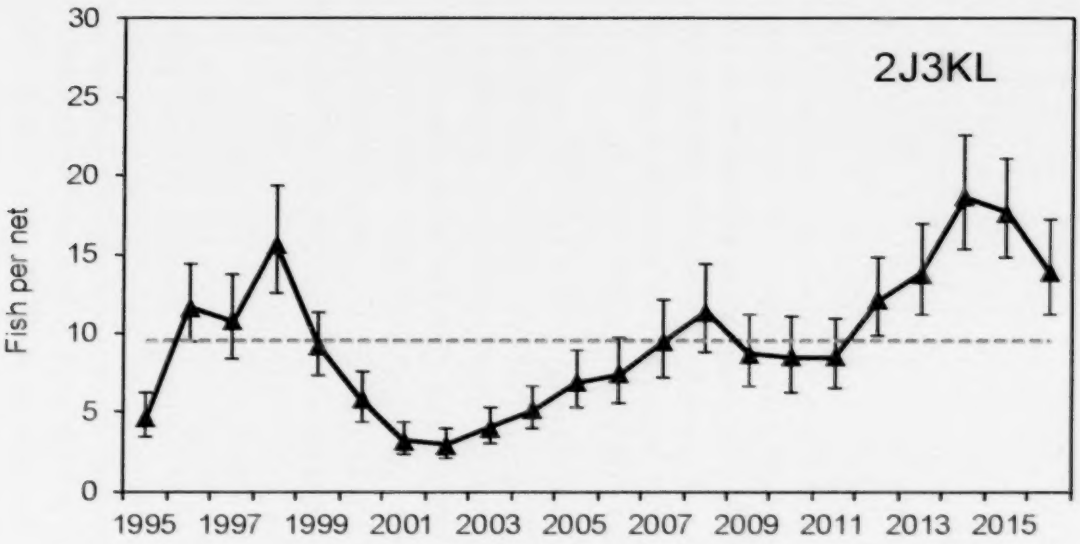

Figure 5: Trends in gillnet (5½ inch mesh) standardized mean catch rate indices from sentinel surveys for NAFO Divs. 2J3KL. Dashed lines indicate time-series average catch rates.

Tagging

Information from recaptures of cod tagged in various regions of Divs. 2J+3KL was used to estimate average annual exploitation (harvest) rates. Most of the cod were tagged in the inshore, but some cod were also tagged offshore in 2008 (Brattey 2013) and 2015. Inshore tagging was conducted during July-October when many migrant offshore cod would be inshore. The tagging data were also used to provide information on the magnitude of the recreational fishery. Recreational catch based on tagging returns has been estimated at 30% of the stewardship fishery landings during 2006-16.

Analysis of tag returns indicate that exploitation levels continued to be low and averaged 4.4% in 2016 (compared with 3.2% in 2015) for cod tagged widely across the stock area. Rather than an assumed value for the annual rate of natural mortality (M), these analyses used population-weighted average M's from 1997-2015 for ages 5-14 estimated in the 2016 stock assessment. An average estimated value of M from the three most recent years (2013-15) was used for 2016. Tagging estimates of harvest rates are based on tagged cod in the 50-85 cm length range at release; these cod would be the range typically captured by commercial gears.

The reporting rate for tags (commercial and recreational harvesters combined) during 1997-2016 averaged 64%; the value for 2016 was 44% which is basically unchanged from 2015 and the lowest in the time series. Reporting rates were also estimated for commercial and recreational harvesters separately; the commercial tag reporting rate during 1997-2016 averaged 69% but shows a declining trend and the value for 2016 was 50%. For recreational harvesters the estimate was 49% with no trend over time. Harvesters should return all tags because low reporting rates can add uncertainty to the estimates of exploitation rates and the analyses of movement patterns and stock structure.

During 2016, commercial harvesters returned more tags (79%) than recreational harvesters (21%), after numbers were adjusted by their respective tag reporting rates. The percentage of

the tags returned by recreational fishers has generally been high (average 33%, range 21% to 47%) during the past 10 years (2007-16). Although the value for 2016 (21%) is the lowest in the time series the results indicate that recreational landings relative to commercial landings are still substantial and that total removals are higher than reported landings.

Conclusions

- A full assessment would have been triggered if the change in the DFO-RV survey biomass index in 2016 was outside the range projected in the previous assessment. This did not occur and advice under the Precautionary Approach from the 2016 full assessment is therefore still valid - removals from all sources should be kept at the lowest possible level until the stock clears the critical zone.
- Abundance and biomass indices from the autumn DFO RV survey in 2016 continued an increasing trend since 2012. In 2016, the biomass index was 7% higher than in 2015.
- Gillnet catch rates from the sentinel survey declined in 2016 but remained above the long term mean.
- Reported catch increased from 4,400 t in 2015 to 10,200 t in 2016. These do not include recreational catch which has been estimated at 30% of the stewardship fishery landings during 2006-2016.
- Tagging results indicated that overall exploitation levels averaged 4.4% in 2016, compared to 3.2% in 2015.

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Appendices

Table 1: Reported landings in NAFO Divs. 2J3KL by management year (nearest thousand metric tons). Detailed catch history is reported in Brattey et al. 2011.

Year	62-76 Avg.	77-91 Avg.	98	99	00/01	01/02	02/03	03/04	06/07 & 07/08[1,2]	08/09[1,2]	09/10 to 12/13[1,2]	13/14 to 15/16[1,2]	16/17
TAC	N/A	N/A	4	9	7	6	6	0	-	-	-	-	-
Can. Fixed	88	90	5	9	5	7	4	1	3	4	4	5	10
Can. Mobile	9	84	-	-	-	-	-	-	-	-	-	-	-
Others	405	38	-	-	-	-	-	-	-	-	-	-	-
Totals	502	212	5	9	5	7	4	1	3	4	4	5	10

[1] *There was no TAC in the last eight years, but fishers were permitted an allowance per license holder of 3,000 lb in 2006/07, 2,500 lb in 2007/08, 3,250 lb in 2008/09, 3,750 lb in 2009/10 to 2012/13, and 5,000 lb in 2013/14 and 2014/15.*

[2] *Does not include Canadian recreational fisheries landings or non-Canadian landings.*

Table 2: Cod abundance (000's) and biomass (t) indices from DFO autumn RV surveys (1992 onwards). Values for years prior to 1992 are reported in Brattey et al. 2011.

Year	2J Abundance	3K Abundance	3L Abundance	Total Abundance	2J Biomass	3K Biomass	3L Biomass	Total Biomass
1992	30,960	61,622	147,158	**239,740**	12,795	35,344	126,323	**174,462**
1993	16,989	36,907	36,813	**90,709**	5,129	14,227	24,596	**43,952**
1994	8,145	9,361	4,291	**21,797**	2,693	4,241	2,874	**9,808**
1995	12,346	23,387	7,733	**43,466**	2,312	4,578	5,115	**12,005**
1996	13,625	18,518	7,066	**39,209**	4,261	5,457	6,140	**15,858**
1997	6,936	8,827	9,859	**25,623**	3,609	3,978	8,991	**16,578**
1998	6,669	15,612	6,454	**28,735**	4,483	7,280	4,804	**16,567**
1999	6,074	29,308	25,281	**60,664**	2,527	12,230	13,611	**28,368**
2000	7,516	35,774	29,010	**72,299**	3,082	11,994	15,070	**30,146**
2001	7,033	28,535	27,724	**63,292**	2,646	9,890	18,706	**31,242**
2002	9,534	41,853	10,984	**62,371**	3,680	11,889	7,460	**23,029**
2003	9,316	19,906	13,638	**42,860**	3,065	4,912	4,849	**12,826**
2004	9,503	34,468	18,605	**62,576**	4,921	9,609	5,266	**19,796**
2005	18,519	33,834	8,780	**61,133**	5,719	16,696	5,118	**27,533**
2006	11,739	52,285	18,711	**82,735**	6,818	38,009	16,982	**61,809**
2007	26,656	54,600	47,248	**128,504**	8,755	58,427	35,722	**102,904**
2008	24,439	62,848	53,958	**141,246**	10,281	71,329	66,401	**148,011**
2009	15,250	47,949	111,782	**174,981**	6,473	51,106	85,410	**142,989**
2010	17,278	83,060	39,013	**139,351**	9,905	89,388	29,255	**128,548**
2011	17,937	59,233	29,204	**106,374**	8,542	71,541	41,615	**121,698**
2012	26,108	101,579	39,584	**167,270**	21,900	101,579	50,985	**185,169**
2013	97,136	170,174	58,344	**325,654**	37,986	181,106	78,927	**298,019**
2014	163,877	210,793	88,706	**463,376**	94,457	166,597	82,471	**343,525**
2015	154,411	281,296	64,706	**500,413**	120,154	256,608	70,820	**447,581**
2016	185,235	275,274	75,582	**536,091**	111,175	307,511	62,611	**481,298**

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